

Effect of secondary relaxation transitions on photo-induced anisotropy in glassy azobenzene-functionalized polymers

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Abstract

© The Royal Society of Chemistry 2017. We propose a physical mechanism for the photo-induced orientation alignment of azo-dyes incorporated in polymers at temperatures far below the glass transition temperature. Using polarized FT-IR spectroscopy, we show that optical dichroism undergoes an observable change at the β -relaxation transition of the azo-polymer when the mobility of the short backbone fragments is increased. We explain this effect using temperature-dependent local strains that occur within the polymer backbones in a glassy state. These strains underlie the enhanced thermal relaxation that drives the orientation kinetics.

<http://dx.doi.org/10.1039/c7tc01652b>

References

- [1] Z. Sekkat and W. Knoll, Photoreactive Organic Thin Films, Academic Press, Amsterdam, 2002
- [2] T. Ikeda O. Tsutsumi Science 1995 268 1873
- [3] X. Meng A. Natansohn C. Barrett P. Rochon Macromolecules 1996 29 946
- [4] A. Bobrovsky V. Shibaev V. Hamplova A. Bubnov V. Novotna M. Kaspar A. Pirayazev D. Anokhin D. Ivanov J. Photochem. Photobiol., A 2016 316 75
- [5] S. S. Kharintsev A. I. Fishman S. K. Saikin S. G. Kazarian Nanoscale 2016 8 19867
- [6] Z. Mahimwalla K. G. Yager J. Mamiya A. Shishido A. Priimagi C. J. Barrett Polym. Bull. 2012 69 967
- [7] J. A. Delaire K. Nakatani Chem. Rev. 2000 100 1817
- [8] N. N. Thi Kim M. Dumont J. A. Delaire K. Nakatani Mol. Cryst. Liq. Cryst. 2005 430 249
- [9] S. Yu. Grebenkin V. M. Syutkin J. Phys. Chem. B 2014 118 2568
- [10] X. Wang K. Yang J. Kumar S. K. Tripathy K. G. Chittibabu L. Li G. Lindsay Macromolecules 1998 31 4126
- [11] F. Lagugné-Labarthe C. Sourisseau R. D. Schaller R. J. Saykally P. Rochon J. Phys. Chem. B 2004 108 17059
- [12] Z. Sekkat M. Buchel H. Orendi H. Menzel W. Knoll Chem. Phys. Lett. 1994 220 497
- [13] Z. Sekkat J. Wood E. F. Aust W. Knoll W. Volksen R. D. Miller J. Opt. Soc. Am. B 1996 13 1713
- [14] R. H. El Halabieh O. Mermut C. J. Barrett Pure Appl. Chem. 2004 76 1445
- [15] C. J. Barrett J. Mamiya K. G. Yager T. Ikeda Soft Matter 2007 3 1249
- [16] V. Toshchevikov M. Saphiannikova G. Heinrich J. Phys. Chem. B 2009 113 5032
- [17] J. Richeton S. Ahzi K. S. Vecchio F. C. Jiang R. R. Adharapurapu Int. J. Solids Struct. 2006 43 2318
- [18] J. Gao Y. He H. Xu B. Song X. Zhang Z. Wang X. Wang Chem. Mater. 2007 19 14
- [19] J. Jae Wie D. H. Wang K. Min Lee L.-S. Tan T. J. White Chem. Mater. 2014 26 5223
- [20] M. Saphiannikova V. Toshchevikov J. Illytskyi Nonlinear Opt., Quantum Opt. 2010 41 27
- [21] S. S. Kharintsev E. A. Chernykh A. I. Fishman S. K. Saikin A. M. Alekseev M. Kh. Salakhov J. Phys. Chem. C 2017 121 3007

- [22] Z. Sekkat D. Morichere M. Dumont R. Loucif-Saibi J. A. Delaire J. Appl. Phys. 1992 71 1543
- [23] H. Ishitobi M. Tanabe Z. Sekkat S. Kawata Opt. Express 2007 15 652
- [24] Z. Sekkat M. Dumont Appl. Phys. B: Photophys. Laser Chem. 1992 54 486
- [25] C. Barrett A. Natansohn P. Rochon Chem. Mater. 1995 7 899
- [26] W. Wie D. H. Wang J. Jae Wie K. Min Lee T. J. White L.-S. Tan Macromolecules 2014 47 659
- [27] D. Hore A. Natansohn P. Rochon Can. J. Chem. 1998 76 1648
- [28] M. Fischer A. El Osman P. A. Blanche M. Dumont Synth. Met. 2000 115 139
- [29] K. Tawa K. Kamada T. Sakaguchi K. Ohta Appl. Spectrosc. 1998 52 1536
- [30] F. J. Rodríguez C. Sanchez B. Villacampa R. Alcala R. Cases M. Millaruelo L. Oriol Polymer 2004 45 2341
- [31] N. A. Nikonorova M. Yu. Balakina O. D. Fominykh M. S. Pudovkin T. A. Vakhonina R. Diaz-Calleja A. V. Yakimansky Chem. Phys. Lett. 2012 552 114
- [32] K. Yager and C. Barrett, in Polymeric Nanostructures and Their Applications, ed., H. S. Halwa, 2006, vol. 8, p. 1
- [33] K. G. Yager C. J. Barrett J. Chem. Phys. 2004 120 1089
- [34] T. Buffeteau F. Lagugne Labarthe M. Pezolet C. Sourisseau Macromolecules 1998 31 7312
- [35] P. Lefin C. Fiorini J.-M. Nunzi Opt. Mater. 1998 9 323
- [36] C. J. Barrett P. L. Rochon A. L. Natansohn J. Chem. Phys. 1998 109 1505
- [37] Y. Atassi J. Chauvin J. A. Delaire J.-F. Delouis I. Fanton-Maltesy K. Nakatani Pure Appl. Chem. 1998 70 2157
- [38] F. Serra E. M. Terentjev J. Chem. Phys. 2008 128 224510
- [39] H. M. D. Bandara S. C. Burdette Chem. Soc. Rev. 2012 41 1809
- [40] R. Loucif-Saibi K. Nakatani J. A. Delaire M. Dumont Z. Sekkat Chem. Mater. 1993 5 229
- [41] P. U. Veer U. Pietsch P. L. Rochon M. Saphiannikova Mol. Cryst. Liq. Cryst. 2008 486 66
- [42] A. I. Fishman A. A. Stolov A. B. Remizov Spectrochim. Acta, Part A 1993 49 1435